Inequality and the composition of taxes*

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Abstract

This paper analyzes the political economics of the composition of taxes. Taxes may be levied on income, or on expenditure, with the median voter pivotal in the theoretical framework analyzed. As in Meltzer and Richard (1981) income taxes increase with inequality. Conversely expenditure taxes first increase and then decrease with increasing inequality. The extent to which taxes are levied on income relative to expenditure unambiguously rises with inequality. In contrast to government size evidence, cross-country data exhibit a robust positive correlation between the extent to which taxes are levied on income relative to expenditure, and inequality. Consistent with the theory this relationship holds most significantly in stronger democracies.

1 Introduction

What determines fiscal policy in democracies? A canonical theoretical result derived by Meltzer and Richard (1981), building on Romer (1975), is that the size of government increases with the degree of inequality in the pre-tax income distribution. This paper develops the Meltzer and Richard (1981) hypothesis to consider the composition of taxes, and in particular the setting of income versus expenditure taxes. The main theoretical prediction is that the extent to which taxes are levied on income relative to expenditure increases with inequality. Cross-country evidence supports this hypothesis.

Cross country evidence testing the Meltzer and Richard (1981) hypothesis is predominantly unsupportive. For example Perotti (1996), Bassett et al (1999) and Persson and Tabellini (2003) all find that the size of government is either insignificantly and/or negatively related to measures of inequality. In response, new theories have emerged through which high levels of inequality can coexist with small government under democracy. Persson (1995) and Benabou (2000) separately identify roles for government in solving particular market failures - respectively excessive labor supply when utility is derived relatively, and underinvestment due to capital market imperfections. The capacity of the electorate to agree on the role of government increases with equality, hence government size increases with equality.[1] Rodriguez (2004) instead proposes that the power of the rich to influence policy increases with inequality. Ultimately, and as also concluded by Borck (2007), the theoretical relationship between total redistribution and inequality extends beyond the mechanism

[1] A separate possibility advanced by Benabou and Ok (2001) is that the prospect of upward income mobility will limit the demand for redistribution under rational expectations. However, the 'Great Gatsby curve' (Krueger, 2012) undermines this argument somewhat as a full reconciliation with the data.

analyzed in Meltzer and Richard (1981). There are multiple channels linking the total size of the government with inequality.

Also in the cross-country context there are many potential determinants of the total size of government beyond the income distribution.[2] Socioeconomic, historical and institutional differences may account for observed differences in government size, and indeed undoubtedly also co-determine differences in the income distribution. The broader literature on the size of government catalogues income levels (Wagner's law, analyzed in Ram, 1987), ideology (Pickering and Rockey, 2011), demographic change (Razin et al 2002), openness (Rodrik, 1998), country size (Alesina and Wacziarg, 1998) and fragmentation (Alesina et al, 1999). Public choice theory characterizes the size of government as the outcome of the power of a bureaucracy that has the capacity to sustain itself (Niskanen, 1971), which also may differ across institutional settings. Persson and Tabellini (1999) and Persson et al (2000) stress the importance of constitutional rules in determining government size.[3] Shelton (2007) provides an extensive survey and examination of this literature.

Consequently an alternative empirical literature instead focusses on testing the hypothesis within countries. Meltzer and Richard (1983) found some support for their hypothesis using data from the US states, and relatedly Alesina et al (2000) found that public employment was higher in US cities with greater levels of inequality. Borge and Rattsø (2004) found that the tax burden shifts from poll taxes to property taxes with greater income inequality across Norwegian local governments.

[2] Moreover, whether public goods are provided by government or by the private sector may theoretically vary with inequality (Horstman and Scharf, 2008).

[3] A separate literature examines the relationship between cultural or social diversity and redistributive policies, for example Bellani and Scervini (2015) and Freier et al (2016).

This paper revisits international evidence, but asks a different, but basic, question: how does income inequality affect the composition of taxes? Arguably total expenditure (and therefore total taxation under a balanced budget) is determined institutionally, or more generally by factors other than the income distribution listed above. But the total size of government is not the only policy lever. Even if the size of the public sector is taken as given, governments still face unresolved questions on the appropriate composition of taxes. Perhaps the most basic question here is the extent to which governments raise taxes on income as opposed to expenditure. Indeed Crawford et al (2007) write that "(t)he appropriate balance between direct and indirect taxation — between income taxes and taxes on goods and services — is one of the oldest issues in public finance, but still imperfectly understood." There is of course an enormous literature analyzing optimal taxation, beginning with Diamond and Mirrlees (1971), but relatively little in the way of a positive analysis of the political economics of the tax composition decision.

A related literature examines the adoption of particular tax instruments, both historically (Aidt and Jensen, 2009a and 2009b) and as an outcome or indeed a driver of the development process (Keen and Lockwood, 2010; Besley and Persson, 2014). However, this literature generally neglects the impact of income inequality on the adoption process.

This paper maintains the essence of the Meltzer and Richard (1981) framework, but instead investigates the composition of taxes. In the model taxes may be levied on income, or on expenditure. The preferred policy of the median voter is the unique Condorcet winner, despite the fact there are two policy instruments, because across individuals the ideal policy mix is still unidimensional in income.[4] For any given level of total redistribution (and hence

[4]This is the condition of 'intermediate preferences' identified by Grandmont (1978).

total taxation), richer (poorer) individuals prefer increasing amounts of expenditure (income) tax relative to income (expenditure) tax, and the median voter decides. Tax preferences derive from comparing before-tax income, which is liable to income tax, with disposable income, which is spent on consumption and thus liable to expenditure tax. The difference between before-tax income and disposable income is increasing with individuals' position in the income distribution, and hence tax composition preferences are monotonic in income.

In particular given a right-skewed income distribution the median voter's before-tax income is less than their expenditure, which is determined by disposable income plus redistribution (financed by aggregate taxation revenue). It therefore follows that a given level of additional redistribution would cost more to them when financed by expenditure taxes than by income taxes, all else equal. However, because there are also different tax collection costs (or deadweight losses) associated with the two policy instruments, an 'interior solution' is feasible in the sense that both tax instruments will be strictly positive. The key point is that as the median voter becomes poorer relative to mean income (and inequality increases), income taxes will be increasingly preferred as a means of funding a particular level of redistribution.

A similar approach is taken by Borge and Rattsø (2004) to analyze the mix of poll and property taxes in Norwegian local governments. As with the present paper in their model policy is three-dimensional, in their case consisting of an indiscriminate poll tax, a tax on housing that increases with the house value, and spending on public services. Like us they find that increased inequality will increase demand for greater redistribution, via increasing the (income-related) housing tax and reducing the poll tax.

Our theoretical findings cohere with Meltzer and Richard (1981) in that greater inequality

monotonically leads to greater reliance on income taxes as a source of revenue. The results relating to expenditure taxes are novel. At low levels of inequality, increases in inequality also lead to higher expenditure tax rates because these are also redistributive (because the rich spend more than the poor hence pay more taxes), and at low tax levels the deadweight losses are relatively small. However, once inequality passes some threshold level, then there is a stronger desire for redistribution, even if this comes at the price of greater deadweight income-tax losses. The median voter now substitutes expenditure taxes for income taxes. Nonetheless, an unambiguous finding is that the composition of taxes, defined as the extent to which taxes are levied on income relative to expenditure, theoretically always rises with inequality.

In a much more general framework than that considered here Winer et al (2009) also analyze how the mix between income and consumption taxes changes with increased skewness in the productivity distribution.[5] In numerical simulations they also find that income taxes increase while consumption taxes fall with increased skewness. The present paper complements this analysis by providing tractable solutions for the policy variables in question, and moreover finds additional results such as the non-monotonicity in consumption taxes. Furthermore we empirically analyze the resultant hypotheses.

We test our hypotheses using cross-country data from the World Development Indicators for over 100 countries from the period 1990-2012. Data measuring the extent to which taxes are levied on earnings relative to expenditure are consistently positively correlated with measures of inequality. This stands in contrast to the evidence testing the standard Meltzer

[5] Their analysis includes heterogeneity in both tastes over public provision and political influence as well in the productivity distribution.

and Richard (1981) hypothesis related to total government size. Moreover income taxes as a percentage of total taxes increase, whilst taxes on expenditure as a percentage of total taxes fall with increased inequality. The magnitude of the estimated effects are quite large. A one-standard deviation increase in inequality is associated with an increase in the ratio of taxes collected from income to taxes collected from expenditure of around half a standard deviation. These statistical relationships hold most significantly in countries with higher levels of democracy, in support of the mechanism proposed in this paper.

The next section provides a theoretical analysis of the political economics of income and expenditure taxation. Section 3 contains the empirical analysis and section 4 concludes.

2 Model

The model is a simple extension of Meltzer and Richard (1981) to include expenditure taxes as well as income taxes. As in that paper, individual expenditure (x_i) is set equal to disposable income,

$$x_i = (1 - t_y)\, y_i + r \tag{1}$$

where t_y is the income tax rate, y_i is pre-tax (ex ante) income, indexed i across the population and r is per capita redistribution. Hence expenditure will be higher (lower) than ex ante income for low- (high-) income individuals. Consumption (c_i) is less than expenditure, because of the presence of an expenditure/consumption tax (t_c), hence

$$c_i = (1 - t_c)\, x_i. \tag{2}$$

The government budget is assumed to balance so that redistribution in per capita terms is financed from consumption and income tax revenue, requiring

$$r = t_c\overline{x} + t_y\overline{y}. \tag{3}$$

Furthermore at the aggregate level income equals expenditure, thus

$$\overline{x} = \overline{y}. \tag{4}$$

In order to maintain tractability the labor-supply decision is not formally modeled, hence maximization of utility amounts to maximization of consumption (because consumption is the only argument in the utility function). The pivotal voter/policymaker thus chooses the triple $\mathbf{q} = \{t_c, t_y, r\}$ in order to maximize their own consumption. Substituting in (4), (3) and (1) into (2) gives

$$c_i = (1 - t_c)\left[(1 - t_y)\, y_i + (t_c + t_y)\,\overline{y}\right] \tag{5}$$

hence the policy problem reduces to two dimensions (t_c and t_y). The important point of departure from Meltzer and Richard (1981) is that there are now two tax instruments being set. In general the Condorcet winner does not exist when the policy problem has two (or more) dimensions, but the structure presented can be re-expressed in terms of (unidimensional) intermediate preferences which means that the choice of the median voter will be pivotal.[6] Grandmont (1978) showed that as long as voters only differ along one dimension

[6] See Persson and Tabellini (2000) p. 25. Borge and Rattso (2004) also employ intermediate preferences to solve a two-dimensional policy problem.

(here, income), and that the indirect utility function ($W(\mathbf{q}; y_i)$) can be written as

$$W(\mathbf{q}; y_i) = J(\mathbf{q}) + K(y_i) H(\mathbf{q}),$$

then the choice of the median voter is a Condorcet winner. It is clear that equation (5) satisfies this requirement.

A final ingredient of the model is that mean income declines with taxes, capturing tax collection and/or 'deadweight' costs. To model this we posit the reduced form relationship

$$\overline{y} = y^* e^{-\delta_y t_y - \delta_c t_c} \tag{6}$$

where y^* is potential income and δ_y and δ_c are parameters defining the sensitivity of actual (taxable) income respectively to income and consumption taxes.[7] The key properties of (6) are that $\frac{d\overline{y}}{dt_y} = -\delta_y \overline{y}$ and $\frac{d\overline{y}}{dt_c} = -\delta_c \overline{y}$, hence that the proportionate deadweight losses, $\frac{d\overline{y}/dt_y}{\overline{y}}$ and $\frac{d\overline{y}/dt_c}{\overline{y}}$, are constant (therefore ruling out scale effects). The parameters δ_y and δ_c represent deadweight losses, either incurred directly as tax collection costs, and/or indirectly in terms of their effects on economic activity. These deadweight losses are non-negative, but in order to generate a meaningful policy tension are less than the tax revenue that may be raised, hence $0 < \delta_y < 1$ and $0 < \delta_c < 1$.

Technically equation (6) certainly facilitates the analysis, and should not be read as a full depiction of how GDP responds to taxes. Nonetheless, we maintain that the arguments of the paper would hold for other specifications of how taxes affect incentives. One of the key arguments in Meltzer and Richard (1981) is that the median voter rationally anticipates

[7] Pickering and Rockey (2011) also posit a reduced form to underpin a similar 'leaky bucket' argument.

incentive effects of higher taxation and hence sets taxes short of the top of the Laffer curve. Regardless of functional form, for there to be a meaningful tension for the median voter, then mean GDP will be falling with taxes (of either form). Equation (6) captures this basic property. In appendix 2 we provide a brief analysis of some possible microfoundations for this relationship, moreover establishing an argument that $\delta_y > \delta_c$, which, as shown below, is required to ensure non-negative expenditure taxation.

One possible interpretation of high values of δ_y is high income tax collection costs.[8] As discussed by Besley and Persson (2014), many countries cannot easily collect income taxes. Arguably both δ_c and δ_y may be higher in the presence of a significant informal economy. Whilst the informal economy is not modeled here, it is intuitive that it is more difficult to levy taxes (which would apply by construction to the formal sector) when economic agents may easily migrate from the formal sector to the informal economy. $\bar{y}$, which here represents the formal economy, would fall more readily with increased taxation.[9] Nonetheless, across groups of countries that are economically and institutionally similar, one might expect that the cost parameters are also similar.

The median voter has income y_m, and we define $m \equiv \frac{\bar{y}}{y_m} > 1$ as the operationalization of inequality as in Meltzer and Richard (1981). Maximization of (5) with respect to t_y, given (6) yields

$$t_c + t_y = \frac{(m-1)}{\delta_y m}. \tag{7}$$

[8] The issue of tax collection costs is independent of the standard deadweight loss argument arising from incentive effects. One common reason given for low taxes in low-income countries is poor state capacity. While we do not model the tax base explicitly, high values of δ_y (or δ_c) could reflect a low tax base, at least in a reduced form sense. A low tax base essentially by definition means high collection costs, and hence potentially high GDP losses associated with attempted tax collection.

[9] La Porta and Shleifer (2014) also argue that agents choose informality as a means of avoiding tax.

The mathematical derivations are contained in appendix 1. Equation (7) immediately delivers the well-known result in Meltzer and Richard (1981) that the total size of government (i.e. $t_c + t_y$) is increasing in inequality (m). Moreover when choosing t_y *for given* t_c the two instruments can be understood as perfect substitutes. Higher t_c permits lower t_y. However, t_c is not a given.

Maximization of (5) with respect to t_c, and using (7), yields

$$t_c = \frac{(m-1)\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]}{m\left[\delta_y\left(m+1\right) - \delta_c\left(m-1\right)\right]}. \tag{8}$$

Again appendix 1 contains more mathematical detail on how (8) is derived. Note that no restrictions are required in order to ensure $t_c < 1$. It is trivially clear from (5) that the median voter will not want to set expenditure taxes in excess of 100% as this will mean negative consumption. $t_c > 0$ requires $\delta_y - \delta_c > \frac{m-1}{m}$. For the median voter to desire positive expenditure taxes at all, there has to be a wedge between δ_y and δ_c. Were δ_y and δ_c equal, then income taxes would always (i.e. irrespective of m) be the preferred policy instrument.[10] The reason for this is that when both types of tax are applied with equal cost (i.e. both incur the same output loss) then the only concern left when choosing the tax composition is redistribution. Given the structure of the tax system, income taxes are inherently more redistributive (dollar for dollar) than consumption taxes. The latter always incur a cost to expenditure, which for the median voter exceeds the cost in terms of (own) income when income taxes are applied. However, when $\delta_y > \delta_c$, then the policy decision becomes more

[10] If unrestricted, then consumption taxes would be negative when $\delta_y = \delta_c$, i.e. a consumption subsidy would be chosen. Indeed such policies have been observed at a microeconomic level at least. If such a policy were implemented, then certainly income taxes would be the preferred means of raising revenue at least. Nonetheless, the widespread existence of expenditure taxes empirically requires that δ_y be sufficiently high.

complex. (And appendix 2 provides some analysis of the labour-leisure choice that could underpin the assumption that $\delta_y > \delta_c$). Income taxes may be preferred on the grounds that ex ante income is less than actual expenditure, but if the tax collection costs are prohibitive, then it becomes optimal for the median voter to instead choose consumption taxes.

Combining equations (7) and (8) yields

$$t_y = \frac{(m-1)}{\delta_y m} - \frac{(m-1)\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]}{m\left[\delta_y\left(m+1\right) - \delta_c\left(m-1\right)\right]}. \tag{9}$$

As shown in the appendix $t_y > 0$ requires no further assumptions. $t_y < 1$ in fact follows a fortiori from $\delta_y - \delta_c > \frac{m-1}{m}$. The proof of this is in the appendix. The intuition here is that δ_y is high enough such that income taxes will not be maximally set.[11]

Using equation (8) and (9) the ratio of income to expenditure taxes is given by

$$\frac{t_y}{t_c} \equiv \tau = \frac{\delta_y\left(m+1\right) - \delta_c\left(m-1\right) - \delta_y\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]}{\delta_y\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]}. \tag{10}$$

Proposition 1 *Assuming that* $0 < \delta_c < \delta_y < 1 < m$*, then the ratio of income to expenditure taxes increases with inequality* (m)*.*

The derivative of equation (10) with respect to m is unambiguously positive under the assumed conditions.[12] Increases in inequality lead to increases in income taxes relative to consumption taxes. The reason is that as inequality increases, then the median voter increasingly prefers income taxes as a means of financing redistribution for given tax collection

[11] This can also be viewed as a shorthand for the plausible general equilibrium result in Meltzer and Richard (1981) that the labor supply will be sufficiently elastic at high income tax rates.

[12] Details are in the appendix.

(or deadweight output losses) costs.

It is also of interest to consider how income and expenditure taxes separately respond to increases in inequality. The more straightforward case is income taxes. In this instance there is no ambiguity: income taxes increase with inequality ($\frac{dt_y}{dm} > 0$ - as shown in the appendix), with exactly the same underpinning as that provided in Meltzer and Richard (1981) (who only consider income taxes).

On the other hand the response of consumption taxes to increasing inequality is non-monotonic. Taking for simplicity the case of $\delta_c = 0$, the derivative of (8) with respect to m is positive or negative depending on

$$(2\delta_y - 3)\, m^2 + 2m + 1 \gtrless 0.$$

Note that the first term is unambiguously negative, hence $\frac{dt_c}{dm} < 0$ for large values of m. The critical threshold is $m = \frac{2+\sqrt{16-8\delta_y}}{2(3-2\delta_y)}$. At levels of inequality below this, increases in inequality lead to higher consumption taxes. At levels beyond the threshold, increases in inequality lead to lower consumption taxes. The intuition for this non-monotonicity lies in the fact that the median voter would all else equal prefer to pay income taxes rather than consumption taxes. *Both* instruments achieve redistribution (holding all else equal), but at low levels of inequality the median voter's income is comparatively close to mean income and the redistributive difference (for the median voter) between the two instruments is relatively small. Here increases in inequality result in *both* types of tax increasing, with the extent depending on the collection costs or deadweight losses associated with each instrument. As inequality increases, a stronger tension between the two instruments arises and the median

voter becomes disposed towards income taxes to the extent that they now substitute away from consumption taxes towards income taxes. Even if income taxes entail higher deadweight losses, they are still preferred because the tax burden to the median voter is reduced when their ex ante income is (increasingly) lower than their expenditure.

Figure 1 depicts how taxes change with inequality under the (arbitrary) parameterization $\delta_y = 0.9$ and $\delta_c = 0.1$.[13] The position of these curves change with these parameters, but the key properties always hold given the conditions outlined. Income taxes monotonically increase a la Meltzer and Richard (1981), whilst expenditure taxes first increase and then decrease with inequality. Note also that the gradient of the income tax curve is always higher than that of the expenditure tax curve, hence $\frac{d\tau}{dm} > 0$ at all levels of inequality.

The model in this section is very stylized and omits several key features of any real-world tax system. For example the marginal propensity to consume may fall with income. This particular consideration would render the expenditure tax as regressive rather than proportionate as above.[14] In a median voter model this would potentially lead to a negative relationship between consumption taxes and inequality. Hence the prediction that τ increases with inequality would hold more strongly were this feature incorporated into the model.[15]

Despite its simplicity, the model sheds light on the tax composition decision in a median voter model. Income taxes monotonically rise with before-tax inequality. When inequality is initially at low levels, then increased inequality will also lead to increased demand for

[13] Note that for the economy to be on the upward slope of the Laffer curve, then using equation (6), then $\frac{d\left(t_y \bar{y}\right)}{dt_y} = \bar{y}\left(1 - \delta_y t_y\right) > 0$ as long as $\delta_y < \frac{1}{t_y}$.

[14] In a simulation study Decoster et al (2010) find indirect (expenditure) taxes to be unambiguously less progressive than other components of the tax system in European countries.

[15] Further extensions could consider how institutions such as the voting rule (Lizzeri and Persico, 2001 and Persson and Tabellini, 1999) or form of government (Persson et al., 2000), though lie beyond the scope of the present paper.

expenditure taxes. The rich spend more, and greater taxes serve to redistribute towards the poor. However, this mechanism is eroded as inequality increases. Tax levels and associated collection costs increase. The median voter now replaces expenditure taxes with income taxes and beyond a certain threshold of inequality further increases in inequality lead to reductions in expenditure taxes. Nonetheless, it is unambiguous that the ratio of income taxes to expenditure taxes increases as inequality increases.

3 Evidence

The main agenda here is to ask whether the composition of taxes across countries systematically changes with inequality. Cross-country income and expenditure tax revenue data are available from the World Development Indicators through 1990-2012. Despite over 20 years of data, there is much more variation in both the policy data and the inequality data across rather than within countries.[16] Consequently we report results from cross-country regressions using within-country averages for all variables used in the analysis. This at least has the advantage of removing any cyclicality from the data, which could also endogenously vary with inequality.

The main dependent variable is constructed from the ratio of the percentage of tax revenue taken from taxes on income, profits and capital gains and the percentage of tax

[16] For example, across the strong democracies (described below) the standard deviation of cross-country mean inequality is 6.24, whilst the average within-country standard deviation is 1.39. For the main policy variable ($\ln(\tau)$ - described below) the standard deviation of the cross-country means is 1.02, whilst the average within-country standard deviation is 0.261.

This feature of the data rules out what would be a scientifically more desirable approach of examining within-country change.

revenue taken from taxes on goods and services, i.e.

$$\tau = \frac{t_y}{t_c} = \frac{\text{Taxes on income, profits and capital gains (\% of revenue)}}{\text{Taxes on goods and services (\% of revenue)}} \tag{11}$$

where both the numerator and denominator are taken from the World Development Indicators (WDI) database. In practice rates vary with different forms of income (and at different levels of income) and goods within countries, but the aggregate measure here is a means of gauging the overall extent of taxes on income relative to taxes on expenditure. In the regression analysis below we use the natural logarithm of τ because there are a small number of outliers where the denominator in (11) is quite small.[17]

Arguably the numerator should only include personal income taxes, since there is no production sector in the model. However, such data are not available in the WDI database. Nonetheless the dependent variable as constructed still should cleanly characterize tensions as identified in the theory above. In practice taxes on profits and capital gains, like income, are more progressive in nature than taxes on expenditure. Increases in inequality would plausibly shift preferred taxes not just towards income taxes, but similarly on taxes applied to profits and capital gains. Data for taxes on personal income as a percentage of total revenue, which more closely corresponds to the theoretical model, are available for 32 OECD members and the correlation coefficient between these data and the WDI data for taxes on income, profit and capital gains is 0.64.

Similarly the denominator ideally should only include consumption taxes rather than on

[17] For example Kiribati, Kuwait and Bahrain all generate less than 1% of their revenue from taxes on goods and services. A further 13 countries derive less than 10%. In the analysis below we test whether the main results hold up when countries with very low revenue from goods and services are excluded.

all forms of expenditure given the focus of the model on voters. Systematic cross-country data isolating taxation revenue derived from private consumption as opposed to other forms of expenditure are not available - though given the fact that aggregate consumption typically represents around 60% of GDP in most countries it seems likely that the data used are reflecting the underlying variable of interest.

As well as examining how $\ln(\tau)$ varies with inequality we also separately analyze how the separate tax measures are respectively affected by inequality. The model above unambiguously predicts a positive impact of inequality on $\ln(\tau)$ and t_y, whilst the effect on t_c is ambiguous.

We use two measures of income inequality in the empirical analysis. The first is the University of Texas Inequality Project's estimate of household income inequality (Galbraith and Kum, 2005). These data (denoted $UTIP$) are constructed using Theil's T statistic to measure pay inequality across sectors in each country. The second are measures of the Gini coefficient ($GINI$) taken from Solt (2016). The two measures are not perfectly correlated (the correlation coefficient is 0.37), which reflects the fact the two series ostensibly are measuring somewhat different concepts. Nonetheless, given undoubted measurement errors in both series, using both enables a robustness check of the empirical work.

One important determinant of the capacity to tax is the level of development, so a first control variables used in the regression analysis is the natural log of GDP per capita in constant chained PPP US$ ($\ln(\overline{y})$) from the Penn World Tables. OECD membership ($OECD$) is also used as a further control, also to some extent capturing the level of development and institutional capacity. Because the alternative tax instruments may redistribute across generations to differing extents, demographic variables (the proportion of the population

aged 15-64 and the proportion aged 65 and above) are also included in the analysis (denoted $PROP1564$ and $PROP65$).

Countries raise tax revenue through means beyond taxation on income and goods and services. One important source is revenue from customs and other import duties. For this reason the trade share (exports plus imports as a percentage of GDP - denoted $TRADE$) is also included in the regression analysis. In addition to these controls the log of the total population size ($\ln(POP)$, also from the WDI) is also included, to account for any scale (dis-)economies associated with particular types of tax collection.[18]

A final control variable is the quality of democratic institutions. The degree of democracy may affect policy variables directly, through channels other than that analyzed above, or indirectly as a proxy for tax capacity. For this reason the $POLITY2$ democracy score is included in the regression analysis as standard. Moreover the median income earner more plausibly drives policy under pure democracy. For this reason the sample is split into countries which score highly on this measure and those that do not. The expectation is that inequality will be more strongly related to the policy variables in the more democratic subsample.

Table 1 contains descriptive statistics of the key variables used in the analysis below. Note first that there is considerable dispersion in both the tax variables. Countries differ meaningfully in terms of how they raise tax revenue. Across the whole sample, taxes on goods and services represent a higher fraction of total revenue than taxes on income. This reflects the fact that in low income countries, the capacity to raise income taxes is often limited. Indeed within the OECD members, income taxes are around 32% of revenue, whilst

[18] Both the trade data and the population data come from the World Development Indicators.

in the rest of the World income taxes are just 20% of revenue. These data are also consistent with Besley and Persson (2014).[19]

The $UTIP$ data cover 129 countries, and numerically range from below 30 (the Czech Republic and Sweden) to 58.2 (Angola), with higher numbers representing greater inequality. Notably, these data are negatively correlated with GDP per capita, with a Pearson correlation coefficient of -0.66. Richer countries are measured (on average) to be more equal than poorer countries (see Galbraith, 2008 for a discussion). This highlights the importance of controlling for economic development, else the inequality measure will be proxying for other potential drivers of policy. Interestingly the $GINI$ data do not exhibit the same correlation with GDP per capita, hence demonstrating the value of using more than one inequality measure.

Before presenting the main results we first report regressions, in Table 2, where the size of government, as measured by average total tax revenue as a share of GDP, is regressed on inequality. This serves to recapitulate the consensus on the absence of evidence supporting the Meltzer and Richard (1981) hypothesis that the total size of government increases with before-tax income inequality. Column 1 is a simple regression with just inequality ($UTIP$) and GDP per capita used as regressors. In that regression, as well as column 2, in which the full controls are used, the size of government is not significantly correlated with inequality.[20] Significance levels do not improve when the sample is split by the quality of democracy. Column 3 contains results for countries with strong democratic credentials, with an average

[19] It is also noteworthy that t_y and t_c sum to (only) about 50% of total revenue. The main source of revenue omitted is that from social security contributions. Because both (derived) benefits and contributions from social security contributions are typically related to wages (the 'Bismarck model' of social insurance) it is problematic to include these contributions in the analysis given that redistribution is lump-sum and uniform in the model.

[20] The sample in column 2 is slightly smaller because the $POLITY2$ data do not cover some of the countries included in column 1.

polity2 democracy score of 7 or above through the sample period.[21] Column 4 contains results for countries with $POLITY2$ democracy scores of less than 7. In neither instance is any statistical relationship found between the size of government and inequality. These findings reflect those found for example in Perotti (1996), Bassett et al (1999) and Persson and Tabellini (2003).[22]

Table 3 contains results when $\ln(\tau)$ is used as the dependent variable. When looking at the full sample both excluding (column 1) and including (column 2) control variables there is a statistically significant positive association between the extent to which countries use income taxes relative to expenditure taxes and inequality. In columns 3 and 4 $UTIP$ is replaced by $GINI$ and the results similarly demonstrate an increased tendency to use income taxes as inequality increases.[23]

One possible concern lies in the fact that the empirical analysis focuses on tax revenue data rather than tax rates. As constructed, the data can be interpreted as *average* tax rates. However, given a progressive income tax structure it is possible that increases in inequality, for given particular income tax rates and thresholds, could lead to higher tax revenue due to the fact that the tax structure is progressive. Higher inequality would, ceteris paribus, lead to a larger number of relatively rich individuals liable to pay higher income taxes. In mitigation even here it would still be the case that the more unequal society effectively chooses to derive a greater fraction of its tax revenue from income taxes - consistent with

[21] This cut-off was chosen for the simple reason that it results in two equally sized subsamples.

[22] Specifically, in column 6 of Table 3.1 of Persson and Tabellini (2003) pp. 40. This regression uses the Deininger and Squire (1996) measure of the Gini coefficient.

[23] When countries with less than 10% of tax revenue derived from goods and services are excluded the significance levels in both columns 2 and 4 actually improves.

In separate unreported regressions using τ rather than $\ln(\tau)$ (and excluding these outliers) the estimation results are statistically very similar to those reported.

the model advanced in this paper. For example, given the potentially higher tax revenue derived from greater inequality when the tax structure is progressive, a polity could decide to lower specific income tax rates across the board. Here specific rates would fall, whilst the average income tax rates (and revenue from alternative sources) could remain the same.

This issue can be investigated further making use of the personal income tax progressivity data developed by Rieth et al (2016). These data unfortunately only cover 30 OECD countries, but still permit an exploratory analysis. Columns 5 and 6 of table 3 duplicate column 1 respectively for two subsamples of low and high measures of personal income tax progressivity.[24] With the caveat that the sample size in both cases is very small, the results indicate that if anything the relationship between $\ln(\tau)$ and inequality is stronger in countries with low income tax progressivity indices, hence at least suggesting that it is not tax progressivity that is driving the results.

Columns 7 and 8 of table 3 contain results replacing the numerator in the dependent variable (11) with the OECD personal income taxation data. Again the caveat of a small sample has to be applied, but still these results are consistent with the previous.[25] When the $GINI$ inequality data are used (in column 8), there is again a positive and statistically significant relationship between the extent to which tax revenue is raised from income as opposed to expenditure, and the degree of inequality.[26]

[24] The median of the Rieth et al (2016) tax progressivity measure is 0.142. Analogous regressions including the control variables led to statistically insignificant results.

[25] Indeed as well as being fairly small the OECD sample also contains a number of relatively young (Eastern European) democracies. There are 10 (out of the 32) countries that are not measured to be fully democratic through 1990-2012 according to the $POLITY2$ score.

[26] The $UTIP$ measure of inequality performs worse in the OECD subsample. One possible factor here is that $UTIP$ is constructed using pay inequality within the industrial sector. In the case of OECD countries, the services sector is quantitatively larger and also of particular importance in driving overall inequality.

In table 4 the sample is separated according to its $POLITY2$ score, measuring the extent of democracy. Columns 1 and 2 use the $UTIP$ inequality measures and split the sample according to $POLITY2 \gtrless 7$ illustrating that the positive relationship holds only under relatively more democratic regimes. This is consistent with the theory above, which relies on a complete franchise. If the median voter earns more than median income then their inclination towards redistribution will be much weaker. When the democracy criterion is strengthened further, so that only countries with $POLITY2 > 8$ (column 3), the magnitude of the estimated coefficient increases and is statistically significant at the 1% level.[27]

The results in columns 1-4 of table 4 establish that the estimated effect is predominantly driven by countries scoring very highly on the $POLITY2$ scale. Notably these data are not normally-distributed, as there is a cluster of (predominantly OECD) countries scoring 10. Many of the regimes with 'intermediate' $POLITY2$ scores (even those with high positive scores) are countries that have experienced substantial political volatility – including democratic reversals. This very likely creates further volatility in terms of fiscal policy decisions. Columns 5 and 6 instead use the more abundant $GINI$ data, which permits splitting the sample according to whether or not $POLITY2 = 10$, hence has been a 'perfect' democracy throughout 1990-2012. Both of the relevant coefficient estimates are positive and statistically different from zero. It is also noteworthy that the coefficient estimate for the perfect democracies (column 5) is significantly larger than that for the other regimes (column 6).

Using the coefficient estimate from column 3 of table 4, a one standard deviation increase in inequality, as measured by $UTIP$, is statistically associated with an increase of 0.46 in

[27] The 11 countries that get dropped in column 3 relative to column 1 are Argentina, Botswana, Colombia, Estonia, El Salvador, South Korea, Macedonia, Moldova, Paraguay, Romania and Turkey.

the policy variable $\ln(\tau)$, holding all else equal. Given that this is nearly a half of the raw standard deviation in the policy variable, the magnitude of the estimated correlation is sizable.[28]

The use of interaction terms provide an alternative approach to examining how the results change with the extent of the franchise. In columns 7 and 8 of table 4 we make use of a democracy indicator variable ($DEMOCRACY$), defined a 0 or 1 depending on whether $POLITY2 > 8$. This indicator variable is then multiplied by the inequality measure thereby generating an interaction term.[29] The hypothesis here is that the relationship between the tax composition measure and inequality will be increasingly positive under democracies, hence that the coefficient estimate for the interaction term is positive. The estimation results confirm this, although in neither instance are the results statistically significant.[30]

One possible concern with these results is the presence of outliers. To check sensitivity to these we computed DFFITS measures for each observation used in column 3 of table 4 following the procedure detailed in Welsch and Kuh (1977) and Belsey et al (1980).[31] Four observations exhibit DFFITS measures greater than one in magnitude - Bolivia, Brazil, Bulgaria and the US. Omission of any one, or indeed all four of these outliers does not change

[28] By means of comparison, using the same regression results, a one standard deviation increase in economic development - as measured by log GDP - is estimated to increase τ by about 1.28. (Confirming the strong role for economic development in determining the structure of taxes.)

[29] An alternative approach would be to interact $POLITY2$ directly with inequality. The drawback of this approach is that countries with intermediate $POLITY2$ scores have tended to be politically more volatile than those with extreme (and hence by construction stable) scores. Undoubtedly political stability has a role to play in determining how taxes are raised, i.e. beyond inequality, although full consideration of this is beyond the scope of the present paper.

[30] It is not impossible that similar political impetus prevails in the non-democracies, albeit via different mechanisms.

[31] DFFITS measures are calculated as $\frac{\widehat{y}_i - \widehat{y_{i(i)}}}{s_{(i)}\sqrt{h(i)}}$ where $\widehat{y}_i$ and $\widehat{y_{i(i)}}$ are the prediction for point i with and without point i in the regression, $s_{(i)}$ is the standard error estimate excluding i, and $h(i)$ is the leverage for point i (Belsey et al, 1980).

the results substantively. In all cases the estimated coefficient is positive with comparable magnitude and remains significant at the 1% level.

In Tables 5 and 6 results are presented respectively for t_y and t_c, the numerator and denominator in (11). In Table 5 the findings for income taxes (t_y) are quite similar to the results found for $\ln(\tau)$. Increases in inequality are generally found to be positively related with the extent to which income taxes are used to raise total revenue, but moreso in the stronger democracies. In countries where $POLITY2 \geq 7$, the estimated effect remains positive, though is not statistically significant, whilst in countries where $POLITY2 < 7$, the estimated relationship is found to be negative, though at a very weak significance level. When the stronger democratic requirement is applied (i.e. where $POLITY2 \geq 8$), the estimated effect increases and is statistically significant at the 5% level. Using the estimate of column 5, a one standard deviation increase in inequality, is statistically associated with an increase of 6.46 in t_y, holding all else equal. As with $\ln(\tau)$, this represents about half of a standard deviation in the policy variable, so again the magnitude of the estimated correlation is sizable.[32] When the sample is refined further to those countries with $POLITY2 = 10$ throughout 1990-2012, and utilizing instead the $GINI$ measure of inequality, (in columns 7 and 8) the positive coefficient estimate is sustained, although statistical significance is in this instance low.[33] Similarly, when the dependent variable is replaced by the OECD personal

[32] The somewhat high parameter estimate for $POLITY2$ in column 3 is worth discussion. Notice also that the parameter estimate for the $POLITY2 \geq 8$ subsample in column 5 does not have this outcome. For both these subsamples there is not much variation in the $POLITY2$ data (as it is truncated at 10). What is happening here is that there are a number of countries with $POLITY2$ scores between 7 and 8 (hence relatively low values for $POLITY2$ in this subsample) which have unusually low income tax revenue. For instance Moldova ($POLITY2 = 7.78$) and Serbia ($POLITY2 = 7.27$) respectively raised only 5.22% and 15.95% of their total tax revenue through income, profits and capital gains taxation.

[33] If all controls except $\ln(\bar{y})$ are dropped, then the p-value of the coefficient estimate pertaining to GINI in column 7 improves to $p = 0.076$.

income taxation data (in columns 9 and 10), the results are statistically insignificant.[34]

In the case of income taxes, some of the results relating to the control variables are of interest. The proportion of the population aged over 65 years is consistently negatively related to income taxes. This is consistent with the findings of Razin, Sadka and Swagel (2002) who found a robust negative relationship between labor tax rates and the dependency ratio. Another regularity in Table 5 is the positive relationship with income per capita. As discussed in Besley and Persson (2014) this likely reflects the greater capacity to tax in richer countries. A further result is that the extent of democracy ($POLITY2$) is positively associated with the extent to which income taxes are used. If income taxes (relative to other forms of taxation) are more progressive, then given the plausible assumption that democratization means that the median voter becomes relatively poorer, then this relationship would be expected.

Table 6 presents results relating to t_c, the extent to which revenue is raised through taxes on expenditure on goods and services. In contrast to income taxes, increases in inequality are generally found to be negatively related with the extent to which expenditure taxes are used, and again this result is especially strong in the stronger democracies. In countries where $POLITY2 \geq 7$, the estimated relationship is negative and statistically significant at the 10% level, whilst in countries where $POLITY2 \geq 8$, the estimated effect is statistically significant at the 5% level. Arguably this could simply reflect a compositional effect: greater t_y must mean less taxes raised elsewhere as a percentage of the total, hence correlations may be reversed for t_c. Nonetheless, because there are other meaningful sources of revenue the results for t_c are not just simply a mirror image for t_y. Indeed the raw correlation between

[34] But as noted above, this subsample is actually quite diverse, arguably moreso than the subset of countries scoring 10 on the $POLITY2$ score.

the two data series used is only -0.08 (for the subsample of democracies with $POLITY2 \geq 8$ it is still only -0.18).[35] The coefficient estimate is also negative when the sample is refined further to those countries with $POLITY2 = 10$ throughout 1990-2012, and utilizing instead the $GINI$ measure of inequality in column 7. As with the income tax results the estimate pertaining to the pure democracies (column 7) is larger in magnitude than that for the rest (column 8), although statistical significance is low.[36] When the sample is restricted to the OECD 32 for which personal income tax data are available (in columns 9 and 10) the negative relationship between expenditure taxes and inequality is sustained.

Using the estimate of column 5 of Table 6, a one standard deviation increase in inequality is statistically associated with an reduction of 5.06 in t_c, holding all else equal. This represents 38% of a standard deviation in t_c, so whilst this is slightly less than that found for t_y this is still a sizable effect.

Again the results relating to the control variables are of worthy of some discussion. In contrast to income taxes there is a negative relationship with income per capita - likely reflecting tax capacity, and the ability to raise taxes through income taxes in particular. However, there are also some interesting differences between the results for t_y and t_c. For example, unlike the case of income taxes the demographic variables are not consistently related with t_c. There is also a consistent negative relationship between t_c and trade (though this relationship is not statistically strong). Globalization may constrain countries' capacity

[35] At first sight this correlation is low. Empirically countries with high levels of social security contributions simultaneously have both lower t_y and t_c. This works against the inherent offsetting effect suggested in the text (higher t_y as defined permits lower t_c). The two effects are working in opposite directions hence the low correlation in the two series.

[36] Again as with the estimates for income taxes, statistical significance improves, this time to $p = 0.08$ when all the controls except $\ln(\bar{y})$ are dropped from column 7.

to tax goods and services - indeed arguably this puts more pressure on countries without the capacity to tax elsewhere (see Khattry and Rao, 2002, and Baunsgaard and Keen, 2010). Interestingly, and as found with t_y the extent of democracy is positively associated with the extent to which expenditure taxes are used. Essentially revenue sources outside of t_y and t_c are increasingly relied upon, the weaker the level of democracy. Given that both forms of taxes are progressive (in the weak sense that both instruments require the rich to pay more), this finding is consistent with the model presented above.

In relation to income taxes the theory above generates an unambiguous hypothesis. Greater inequality results in greater use of income taxes as a source of revenue. The data are supportive of this hypothesis, at least in strong democracies. However, the hypotheses relating to how taxes on expenditure are related to inequality are more nuanced. Increases in inequality are proposed to increase expenditure tax rates at low levels of inequality, and once some threshold level of inequality is reached, then the relationship becomes negative. In the empirical analysis the relationship is unambiguously negative. To test for non-monotonicity a quadratic term in $UTIP$ is included in the analysis. Table 7 contains the results, in column 1 for the full sample, in column 2 for countries with $POLITY2 \geq 7$ and in column 3 for countries with $POLITY2 \geq 8$. In all three cases the estimated sign on the point estimate for the linear term ($UTIP$) is positive, whilst the sign on the point estimate for the quadratic term ($UTIP^2$) is negative, consistent with the theory above. However, in all three cases the results are statistically insignificant.[37]

One possible way of reconciling these results with the model would be to argue that the

[37] This insignificance is underlined by the fact that the R^2 is unchanged.

Similarly when the $GINI$ data were used instead, the linear terms were estimated to be positive and the quadratic terms estimated to be negative, though in all cases the results were statistically insignificant.

observed inequality levels in the sample predominantly (or completely) exceed the threshold value in the model. It is also possible that the model fails to fully account for the effect of inequality on expenditure taxes. As noted towards the end of Section 2 the marginal propensity to consume may fall with income, which could lead to an unambiguous negative relationship. More mundanely, it is also possible that identification of a clear non-linear relationship would go beyond the capacity of the available data.

4 Conclusion

This paper analyzes how the composition of taxes is determined in a simple median voter framework. Taxes may be levied on income, or on expenditure, as in the case of a sales tax. In the framework analyzed the median voter is a Condorcet winner despite the fact there are two policy instruments. The results relating to income taxes are familiar. As with Meltzer and Richard (1981) greater inequality monotonically leads to higher income taxes.

The results relating to expenditure taxes are novel. At low levels of inequality, increases in inequality lead to higher expenditure tax rates. Even though expenditure taxes are not as effective at redistributing as income taxes, there is still a redistributive impetus embodied within an expenditure tax, as the rich spend more than the poor. If expenditure taxes are preferred for separate reasons, perhaps because of smaller deadweight losses or collection costs, then the standard argument - that greater inequality leads to higher taxes - also applies to expenditure taxes.

However, once inequality passes some threshold level, then there is a stronger desire for redistribution, even if this comes at the price of greater deadweight losses. The median voter

now substitutes income taxes for expenditure taxes. Nonetheless, an unambiguous finding is that the composition of taxes, defined as the extent to which taxes are levied on income relative to expenditure, will rise with inequality.

Using cross-country data for tax composition from the WDI, and inequality data from the Texas Inequality Project and Solt (2016), there is a consistently positive correlation between inequality and the extent to which taxes are levied on income relative to expenditure. This contrasts with evidence on total government size testing the original Meltzer and Richard (1981) hypothesis. Moreover income taxes as a proportion of total revenues increase with inequality, whilst expenditure taxes as a proportion of total revenues fall with inequality. Given the nature of cross-country data, and in particular unobserved heterogeneity across countries, it is not possible to say that these are causal relationships. Nonetheless, the fact that the empirical results hold most strongly for countries with higher levels of democracy, is supportive of the mechanism proposed in this paper.

Appendix 1

Derivation of equations (7) and (8).

Inserting (6) into (5) for the median voter yields

$$c_m = (1 - t_c)\left[(1 - t_y)\, y_m + (t_c + t_y)\, y^* e^{-\delta_y t_y - \delta_c t_c}\right].$$

Differentiating this expression with respect to t_y gives

$$\frac{dc_m}{dt_y} = (1 - t_c)\left[-y_m + y^* e^{-\delta_y t_y - \delta_c t_c} - (t_c + t_y)\, \delta_y \overline{y}\right]$$

and it is clear that the second-order derivative is negative hence the sufficient condition is also satisfied. Maximum consumption is therefore defined by

$$(1 - t_c)\left[\overline{y} - (t_c + t_y)\, \delta_y \overline{y} - y_m\right] = 0$$

(using $\overline{y} = y^* e^{-\delta_y t_y - \delta_c t_c}$.) Given that $t_c < 1$, and dividing through by y_m (hence using $m \equiv \frac{\bar{y}}{y_m}$) this requires

$$m - (t_c + t_y)\, \delta_y m - 1 = 0$$

which can be rearranged to give (7) in the text.

Similarly inserting (6) into (5) for the median voter and differentiating with respect to t_c (again the second-order derivative is negative hence the sufficient condition is satisfied) and

setting the resulting expression equal to zero gives

$$(1-t_c)\left[\overline{y}-(t_c+t_y)\,\delta_c\overline{y}\right]-\left[(1-t_y)\,y_m+(t_c+t_y)\,\overline{y}\right]=0.$$

Dividing through by y_m implies

$$(1-t_c)\left[m-(t_c+t_y)\,\delta_c m\right]=(1-t_y)+(t_c+t_y)\,m$$

and substituting for (t_c+t_y) using (7) on both sides of this equation gives

$$(1-t_c)\left[m-\frac{(m-1)\,\delta_c}{\delta_y}\right]=1-t_y+\frac{(m-1)}{\delta_y}.$$

Substituting for t_y using (7) gives

$$(1-t_c)\left[m-\frac{(m-1)\,\delta_c}{\delta_y}\right]=1+t_c-\frac{(m-1)}{\delta_y m}+\frac{(m-1)}{\delta_y}$$

and finally rearranging for t_c yields equation (8) in the text.

Proof that $t_y>0$.

Using (9), then $t_y>0$ requires that

$$\frac{(m-1)}{\delta_y m}>\frac{(m-1)\left[m\left(\delta_y-\delta_c\right)-(m-1)\right]}{m\left[\delta_y\left(m+1\right)-\delta_c\left(m-1\right)\right]}$$

and hence that

$$\left(\delta_y-\delta_c\right)m+\delta_y+\delta_c>\delta_y m\left(\delta_y-\delta_c\right)-\delta_y\left(m-1\right)$$

which must hold given $0 < \delta_c < \delta_y < 1 < m$.

Proof that $t_y < 1$.

Using again (9), then $t_y < 1$ requires that

$$\frac{(m-1)}{\delta_y m} - \frac{(m-1)\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]}{m\left[\delta_y\left(m+1\right) - \delta_c\left(m-1\right)\right]} < 1.$$

In turn this implies:

$$(m-1)\, mX < \delta_y m^2 X + \delta_y m\left(m-1\right)\left[m\left(\delta_y - \delta_c\right) - (m-1)\right]$$

where $X \equiv \delta_y\left(m+1\right) - \delta_c\left(m-1\right) > 0$ and hence

$$(m-1)\, X < \delta_y m X + \delta_y\left(m-1\right)\left[m\left(\delta_y - \delta_c\right) - (m-1)\right].$$

Note that the second term on the RHS is positive given $\delta_y - \delta_c > \frac{m-1}{m}$. It therefore follows that the inequality holds a fortiori if

$$(m-1)\, X < \delta_y m X$$

which must hold because $\delta_y - \delta_c > \frac{m-1}{m}$ strongly implies that $\delta_y > \frac{m-1}{m}$.

Proof that $\frac{d\tau}{dm} > 0$.

Using the quotient rule, differentiating (10) with respect to m gives

$$\frac{\left[\left(\delta_y - \delta_c\right) - \delta_y\left(\delta_y - \delta_c - 1\right)\right]\delta_y Y - \left(\delta_y\left(\delta_y - \delta_c - 1\right)\right)\left(X - \delta_y Y\right)}{\left(\delta_y Y\right)^2}$$

where $Y \equiv [m(\delta_y - \delta_c) - (m-1)] > 0$. $\frac{d\tau}{dm} > 0$ therefore requires

$$(\delta_y - \delta_c) Y - (\delta_y - \delta_c - 1) X > 0$$

which is unambiguously positive given $0 < \delta_c < \delta_y < 1 < m$.

Proof that $\frac{dt_y}{dm} > 0$.

Rewriting (9) as

$$t_y = \frac{(m-1) X - \delta_y (m-1) Y}{\delta_y m X},$$

and differentiating with respect to m therefore requires

$$\{X + (m-1) D - \delta_y [Y + (m-1)(D-1)]\} \delta_y m X - \delta_y (X + mD) [(m-1) X - \delta_y (m-1) Y] > 0$$

where $D \equiv \delta_y - \delta_c > 0$. This simplifies to

$$\delta_y X^2 - \delta_y XY - \delta_y^2 (m-1)(D-1) mX + \delta_y^2 mD (m-1) Y > 0.$$

Given $0 < \delta_c < \delta_y < 1 < m$ then $X > Y$ and $\delta_y X^2 > \delta_y^2 XY$. Given that these same conditions also imply that $D < 1$, then the third term is also positive and hence $\frac{dt_y}{dm} > 0$.

Appendix 2

In this appendix we provide a brief analysis of some possible microfoundations for equation (6), and concurrently an argument for the assumption that $\delta_y > \delta_c$.

Consider a very simple model where individual income is directly determined by their labor supply (L_i) according to $L_i = y_i$. Suppose the labor-leisure choice is governed by:

$$\max_{l_i} W = c_i + \beta \ln l_i$$

where $l_i = \overline{L} - L_i$ is leisure, $\overline{L}$ is the fixed time endowment and β is a taste parameter. The log-linear functional form is not necessary for the main argument, but simplifies the exposition. Given equation (5) then

$$\max_{l_i} W = (1 - t_c) \left[(1 - t_y) \left(\overline{L} - l_i \right) + (t_c + t_y) \overline{y} \right] + \beta \ln l_i.$$

Maximizing with respect to l_i and then solving for the labor supply gives

$$L_i = \overline{L} - \frac{\beta}{(1 - t_c)(1 - t_y) + (1 - t_c)(t_c + t_y)\Delta}$$

where $\Delta \equiv \frac{d\overline{y}}{dL_i} \left(= -\frac{d\overline{y}}{dl_i} \right)$. Equation (6) requires that the labor supply be falling with increased taxation. In the case of income taxes,

$$\frac{dL_i}{dt_y} = -\frac{\beta (1 - t_c)(1 - \Delta)}{Z^2} \tag{A1}$$

where $Z \equiv (1 - t_c)\left[(1 - t_y) + (t_c + t_y)\,\Delta\right]$. In the case of expenditure taxes,

$$\frac{dL_i}{dt_c} = -\frac{\beta\left[(1 - t_y) + (t_c + t_y)\,\Delta - (1 - t_c)\,\Delta\right]}{Z^2}. \tag{A2}$$

For particular (low) values of Δ the labor supply (and hence mean GDP) falls with increased taxation (of either type).

Comparison of Equations (A1) and (A2) reveals that $\left|\frac{dL_i}{dt_y}\right| > \left|\frac{dL_i}{dt_c}\right|$ if Δ is small, and $t_y > t_c$. Under these conditions the extent to which labor supply falls with increased taxation is greater in the context of income taxes than expenditure taxes, hence it is theoretically feasible (and consistent with our analysis) that $\delta_y > \delta_c$. Moreover a more fully developed model that for example considered labour demand as well as demand and supply for goods and services could also conceivably generate this (or indeed the reverse) result, though a full analysis is beyond the scope of this paper.

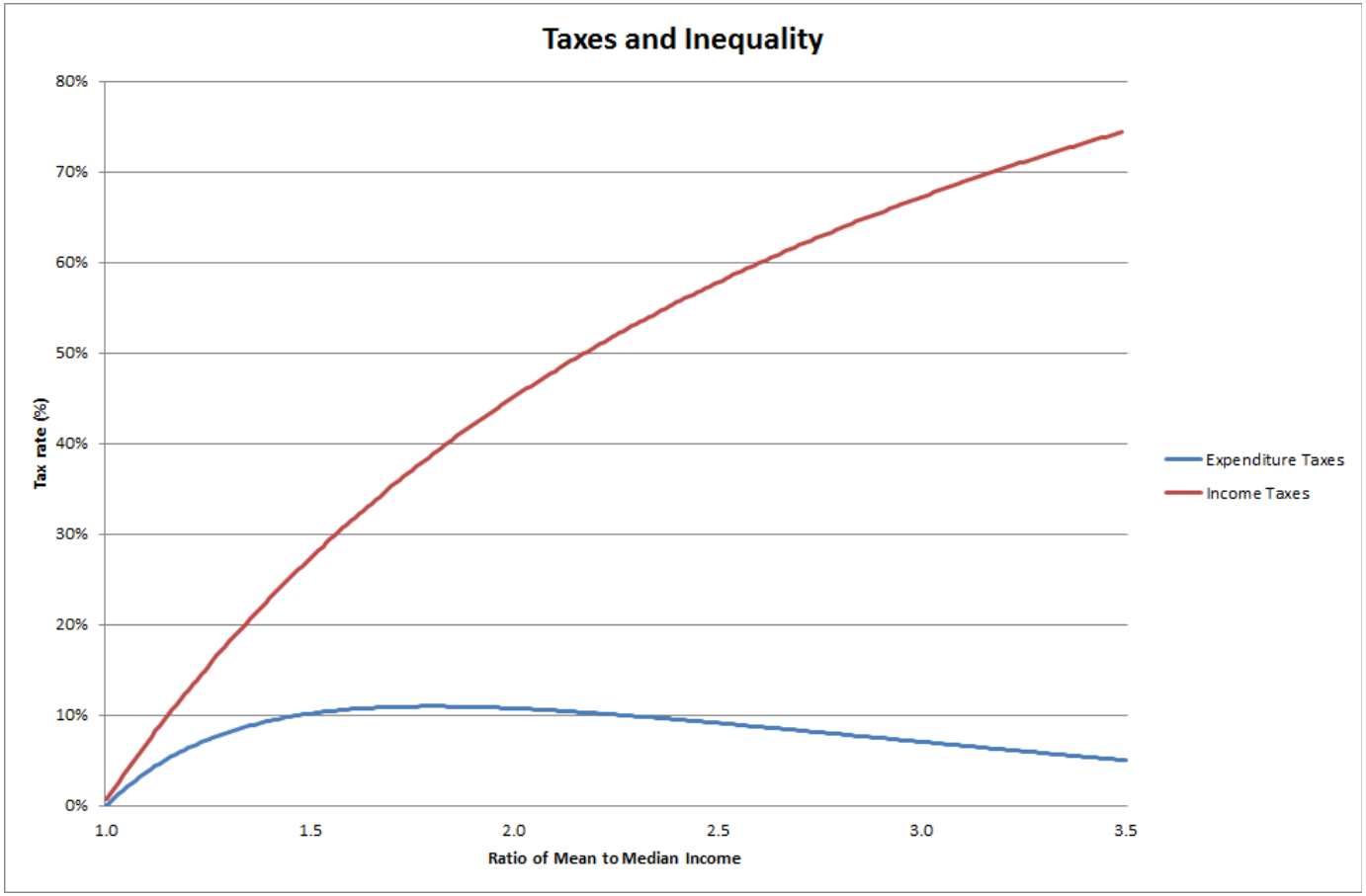

Figure 1: How Expenditure and Income Taxes change with Inequality

Table 1. Descriptive Statistics

	# obs	mean	s.d.	min	max
t_y	158	22.26	12.12	0.604	64.36
t_c	160	29.07	13.47	0.108	75.07
$\ln(\tau)$	157	-0.24	0.98	-2.80	4.57
$\ln(\overline{y})$	166	8.63	1.26	5.60	11.22
$UTIP$	129	44.03	6.49	29.08	58.25
$GINI$	166	45.14	7.21	27.87	68.96
$PROP1564$	194	61.23	6.57	48.52	76.78
$PROP65$	194	7.00	4.62	0.81	18.39
$TRADE$	191	86.69	47.42	2.15	360.5
$OECD$	213	0.138	0.333	0	1
$\ln POP$	213	15.07	2.36	9.16	20.96
$POLITY2$	165	3.03	6.20	-10	10

The data are within-country averages between 1990-2014. t_y denotes taxes on income, profits and capital gains (as a % of revenue) - taken from the World Development Indicators (WDI). t_c denotes taxes on goods and services (as a % of revenue) - also taken from the WDI. $\tau = \frac{t_y}{t_c}$. $\overline{y}$ is real GDP at chained PPPs in 2005 US dollars per capita - taken from the Penn World Tables. $UTIP$ is the University of Texas Inequality Project estimate of household income inequality. $GINI$ are measures of the Gini coefficient taken from Solt (2016). $PROP1564$ and $PROP65$ are respectively the proportion of the population aged between 15 and 64, and 65 and above. $TRADE$ is imports plus exports as a percentage of GDP. $OECD$ is a dummy variable denoting OECD membership. POP is the country population size. $POLITY2$ is a measure of democracy provided by the Polity IV project, with 10 denoting the highest level of democracy, and -10 denoting the highest level of autocracy.

Dep Var: $\frac{t}{y}$	(1)	(2)	(3)	(4)
$UTIP$	−0.177	0.077	0.089	0.190
	(0.147)	(0.198)	(0.209)	(0.301)
$\ln(\bar{y})$	1.155	0.737	3.032*	−1.384
	(0.786)	(1.368)	(1.599)	(1.595)
$OECD$		1.810	1.542	0.225
		(2.803)	(3.242)	(3.577)
$PROP1564$		−0.195	−0.212	−0.023
		(0.174)	(0.219)	(0.292)
$PROP65$		0.183	−0.236	0.516
		(0.204)	(0.298)	(0.367)
$TRADE$		0.019	−0.033	0.047
		(0.022)	(0.024)	(0.039)
$\ln(POP)$		−1.460***	2.489***	−1.127*
		(0.432)	(0.683)	(0.578)
$POLITY2$		0.254*	0.987	0.103
		(0.150)	(0.886)	(0.162)
Obs	119	112	56	56
Sample	Full	Full	POLITY2≥7	POLITY2<7
R^2	0.11	0.29	0.37	0.25

Table 2: Estimation Results - the size of government

Notes: Cross country regressions of total tax revenue as a percentage share of GDP including $\ln(\bar{y})$, $PROP1564$, $PROP65$, $TRADE$, $\ln(POP)$ and $POLITY2$ as control variables described in the text. Robust standard errors are reported in parentheses. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.

Dep Var: $\ln(\tau)$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$UTIP$	0.076^{***} (0.016)	0.027^{*} (0.016)			0.118^{**} (0.016)	0.061 (0.049)	0.041 (0.456)	
$GINI$			0.035^{***} (0.008)	0.019^{*} (0.010)				0.046^{**} (0.018)
$\ln(\bar{y})$	0.428^{***} (0.259)	0.733^{***} (0.138)	0.110^{*} (0.056)	0.454^{***} (0.160)	2.066^{**} (0.701)	0.986 (0.562)	1.190^{***} (0.426)	1.055^{***} (0.350)
OECD		0.374 (0.313)		0.546 (0.293)*				
$PROP1564$		-0.068^{***} (0.022)		-0.047^{*} (0.024)				
$PROP65$		-0.082^{***} (0.024)		-0.083^{***} (0.027)				
$TRADE$		0.001 (0.001)		0.001 (0.001)				
$\ln POP$		0.127^{**} (0.058)		0.141^{**} (0.057)				
$POLITY2$		-0.012 (0.015)		-0.006 (0.014)				
Obs	117	111	138	128	14	16	32	32
Sample	Full	Full	Full	Full	Low Prog	High Prog	OECD	OECD
R^2	0.19	0.43	0.12	0.35	0.61	0.26	0.38	0.41

Table 3: Estimation Results: the composition of taxes

Notes: As for Table 2. Columns 5 and 6 divide the 30 observations of Rieth et al (2016) according to whether the observed average personal income tax progressivity index lies below (column 5) or above (column 6) the median value of 0.142. Columns 7 and 8 replace the WDI income + profit + capital gains data with OECD personal income taxation data.

Dep Var: $\ln(\tau)$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$UTIP$	0.047^{*}	0.021	0.071^{***}	0.007			0.023	
	(0.024)	(0.023)	(0.021)	(0.022)			(0.016)	
UTIP*DEMOCRACY							0.006	
							(0.005)	
$GINI$					0.078^{**}	0.018^{*}		0.017
					(0.028)	(0.011)		(0.016)
GINI*DEMOCRACY								0.004
								(0.004)
$\ln(\overline{y})$	0.859^{***}	0.561^{***}	1.014^{***}	0.629^{***}	1.917^{***}	0.395^{**}	0.689^{***}	0.435^{***}
	(0.286)	(0.193)	(0.299)	(0.163)	(0.496)	(0.167)	(0.139)	(0.161)
OECD	0.038	-1.204^{***}	0.161	-0.736^{*}	-0.403	0.011	0.369	0.514^{*}
	(0.432)	(0.418)	(0.390)	(0.408)	(0.463)	(0.356)	(0.294)	(0.293)
$PROP1564$	-0.031	-0.035	0.019	-0.048^{*}	0.139^{***}	-0.042	-0.066^{***}	-0.045^{*}
	(0.041)	(0.028)	(0.047)	(0.025)	(0.045)	(0.025)	(0.021)	(0.024)
$PROP65$	-0.072^{**}	-0.166^{***}	-0.094^{**}	-0.148^{***}	-0.180^{***}	-0.085^{***}	-0.085^{***}	-0.086^{***}
	(0.029)	(0.041)	(0.036)	(0.034)	(0.032)	(0.029)	(0.023)	(0.026)
$TRADE$	0.000	0.002	0.001	0.001	-0.008^{**}	0.003^{*}	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.001)	(0.002)
$\ln POP$	0.160^{*}	0.119	0.229^{**}	0.088	0.154	0.124^{*}	0.124^{**}	0.141^{**}
	(0.093)	(0.087)	(0.100)	(0.080)	(0.121)	(0.063)	(0.059)	(0.058)
$POLITY2$	0.122	-0.008	0.115	-0.010		-0.003	-0.025	-0.012
	(0.115)	(0.023)	(0.117)	(0.020)		(0.015)	(0.020)	(0.016)
Obs	56	55	45	66	26	102	111	128
Sample	POLITY2$\geq$7	POLITY2<7	POLITY2$\geq$8	POLITY2<8	POLITY2=10	POLITY2<10	Full	Full
R^2	0.54	0.48	0.62	0.48	0.85	0.31	0.44	0.35

Table 4: Estimation Results - the composition of taxes

Notes: As for Table 2.

Dep Var: t_y	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$UTIP$	0.524^{*}	0.185	0.586	-0.045	0.995^{**}	-0.060			-0.092	
	(0.300)	(0.307)	(0.496)	(0.448)	(0.435)	(0.391)			(0.456)	
$GINI$							1.472	0.259^{*}		0.303
							(1.055)	(0.139)		(0.283)
$\ln(\bar{y})$	4.576^{***}	6.770^{***}	8.078^{**}	5.523^{*}	15.254^{***}	4.530^{**}	30.81^{***}	5.410^{***}	13.15^{***}	13.61^{***}
	(1.538)	(1.856)	(3.232)	(2.954)	(3.947)	(2.237)	(10.14)	(1.843)	(4.842)	(4.412)
OECD		7.277	5.686	-3.330	7.307	-4.244	0.005	-1.280		
		(4.703)	(6.861)	(7.190)	(6.833)	(6.516)	(7.650)	(5.021)		
$PROP1564$		-0.453	0.146	-0.257	0.403	-0.224	2.736^{*}	-0.111		
		(0.321)	(0.577)	(0.520)	(0.838)	(0.433)	(1.513)	(0.289)		
$PROP65$		-1.351^{***}	-1.360^{**}	-1.952^{**}	-2.067^{***}	-1.728^{***}	-3.315^{***}	-1.456^{***}		
		(0.420)	(0.602)	(0.733)	(0.750)	(0.615)	(0.655)	(0.412)		
$TRADE$		0.016	-0.037	0.034	-0.055	0.038	-0.205^{**}	0.026		
		(0.025)	(0.052)	(0.033)	(0.053)	(0.030)	(0.093)	(0.026)		
$\ln POP$		1.921^{**}	1.101	2.006^{*}	1.404	1.885^{*}	-1.499	1.643^{**}		
		(0.815)	(1.517)	(1.093)	(1.549)	(1.041)	(3.692)	(0.698)		
$POLITY2$		0.539^{**}	3.322^{*}	0.733^{*}	0.602	0.485		0.293		
		(0.266)	(1.724)	(0.387)	(3.460)	(0.319)		(0.204)		
Obs	118	112	56	56	45	67	26	102	32	32
Sample	Full	Full	POLITY2$\geq$7	POLITY2<7	POLITY2$\geq$8	POLITY2<8	POLITY2=10	POLITY2<10	OECD	OECD
R^2	0.11	0.31	0.43	0.48	0.51	0.27	0.72	0.27	0.25	0.27

Table 5: Estimation Results - income taxes

Notes: As for Table 2. Columns 9 and 10 replace the WDI income + profit + capital gains data with OECD personal income taxation data.

Dep Var: t_c	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$UTIP$	-0.892^{***} (0.268)	-0.317 (0.302)	-0.591^{*} (0.342)	-0.174 (0.445)	-0.779^{**} (0.364)	-0.001 (0.429)			-0.729^{*} (0.360)	
$GINI$							-0.627 (0.595)	-0.186 (0.193)		-0.616^{*} (0.335)
$\ln(\bar{y})$	-4.130^{***} (1.493)	-7.488^{***} (2.093)	-9.416^{***} (3.232)	-5.202 (3.844)	-8.226^{**} (3.400)	-6.819^{**} (2.876)	-16.77^{***} (6.308)	-2.770 (2.658)	-11.74^{***} (4.083)	-9.238^{***} (3.227)
OECD		-1.394 (4.318)	1.508 (4.135)	32.98^{***} (8.105)	-2.470 (3.837)	15.39 (9.746)	5.839 (5.449)	0.931 (6.060)		
$PROP1564$		0.891^{**} (0.373)	0.603 (0.447)	0.517 (0.631)	0.034 (0.521)	0.629 (0.509)	-1.079 (1.012)	0.688 (0.463)		
$PROP65$		0.296 (0.416)	0.212 (0.358)	1.270 (0.775)	0.297 (0.389)	1.277^{**} (0.619)	0.915^{*} (0.511)	0.228 (0.440)		
$TRADE$		-0.026 (0.023)	-0.031 (0.031)	-0.034 (0.035)	-0.039 (0.034)	-0.015 (0.032)	0.050 (0.041)	-0.058^{**} (0.025)		
$\ln POP$		-1.091 (0.833)	-2.172^{**} (0.923)	-0.541 (1.453)	-2.538^{**} (0.998)	-0.202 (1.255)	-2.574 (1.714)	-0.946 (0.995)		
$POLITY2$		0.464 (0.287)	0.326 (1.437)	0.614 (0.446)	0.220 (1.851)	0.429 (0.377)		0.295 (0.334)		
Obs	118	111	56	55	45	66	26	102	32	32
Sample	Full	Full	POLITY2$\geq$7	POLITY2<7	POLITY2$\geq$8	POLITY2<8	POLITY2=10	POLITY2<10	OECD	OECD
R^2	0.12	0.24	0.45	0.33	0.47	0.31	0.70	0.14	0.29	0.27

Table 6: Estimation Results - expenditure taxes

Notes: As for Table 5.

Dep Var: t_c	(1)	(2)	(3)
$UTIP$	0.032	0.645	0.988
	(1.867)	(2.093)	(1.903)
$UTIP^2$	−0.004	−0.016	−0.022
	(0.022)	(0.027)	(0.025)
$\ln(\bar{y})$	−7.463***	−9.549***	−8.681**
	(2.075)	(2.613)	(3.532)
OECD	−1.295	1.631	−1.939
	(4.528)	(4.156)	(3.825)
$PROP1564$	0.881**	0.555	−0.024
	(0.373)	(0.462)	(0.519)
$PROP65$	0.306	0.174	0.239
	(0.406)	(0.362)	(0.400)
$TRADE$	−0.026	−0.031	−0.039
	(0.022)	(0.032)	(0.035)
$\ln POP$	−1.106	−2.171**	−2.628**
	(0.831)	(0.935)	(1.015)
$POLITY2$	0.457	0.411	0.066
	(0.295)	(1.493)	(1.837)
Obs	111	56	45
Sample	Full	POLITY2≥7	POLITY2≥8
R^2	0.24	0.45	0.47

Table 7: Estimation Results

Notes: As for Table 2.

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